Unit 2

Part 2

Matter Exchange & Transfer

AP Biology

Ms. Passamonti

Open Systems

- Life depends on it's environment to obtain resources
- Open systems allow materials to move in and out of those systems (organisms)
- Atoms & Molecules are the building blocks and organisms must obtain them to grow, reproduce & maintain organization.

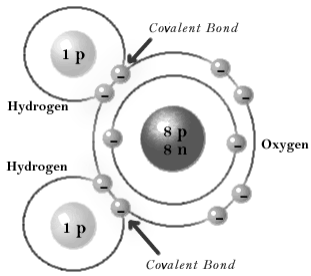
98% of the Atoms in Organisms…

- Sulfur
- Phosphorous
- Oxygen
- Nitrogen
- Carbon
- Hydrogen

- SPONCH

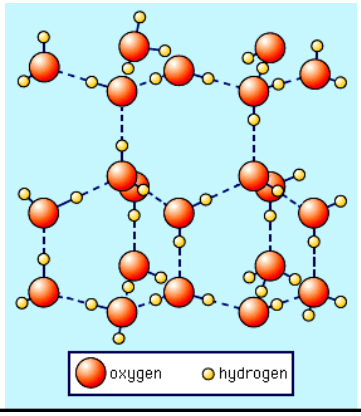
Water

- 1 Oxygen atom bound to 2 Hydrogen atoms
- Oxygen is electronegative – shifts electrons towards itself easily!
- Results in 2 polar covalent bonds



Water

- Makes water “sticky”
- Other polar molecules form sticky bonds = **Hydrogen Bonding**



Water

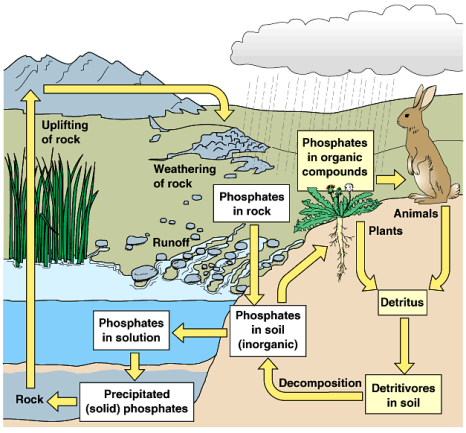
- As a result of polarity & hydrogen bonding, water is…
  - Able to dissolve almost any compound
    - Universal Solvent supporting reactions
  - Difficult to change from one phase to another
    - Allows for a large quantity of heat to be absorbed/released before “boiling” or “freezing”

Nitrogen

- Polar also, very similar to Oxygen
- Nitrogen w/ hydrogen = ammonia
- Alternate medium for life???
  - Not likely but not impossible on other planets!
- Moves from the environment to organisms; used in proteins & nucleic acids (DNA/RNA).

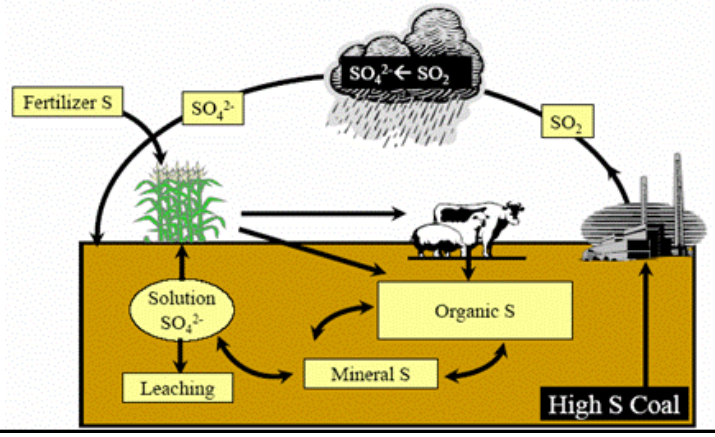
Phosphorous

- Used in Nucleic Acids, Membrane Lipids & Many cellular intermediates (ADP→ ATP)



Sulfur

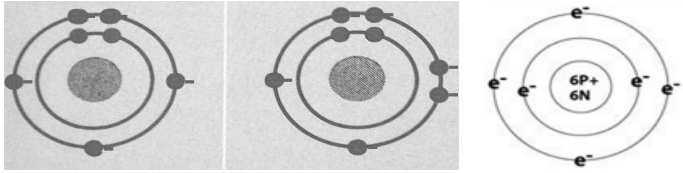
- Used in Proteins – forms strong covalent bonds between amino acids.



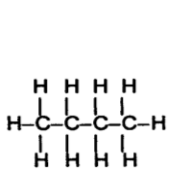
Carbon

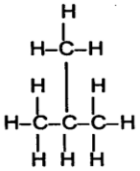
- Used in storage compounds and cell formation in ALL organisms.
- Why is carbon so special?
- ***Tetra***valence: Forms 4 covalent bonds

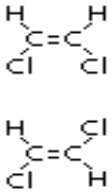
Nitrogen Oxygen Carbon

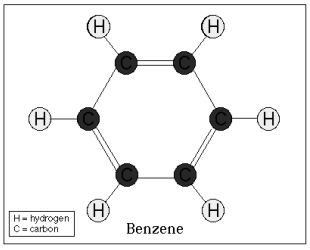


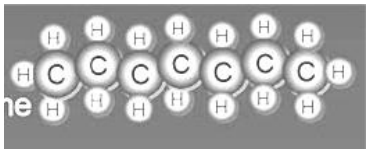
Structural Genius!

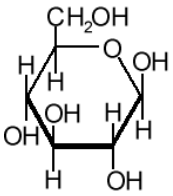


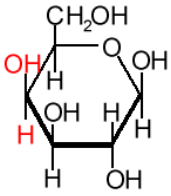












Glucose Galactose

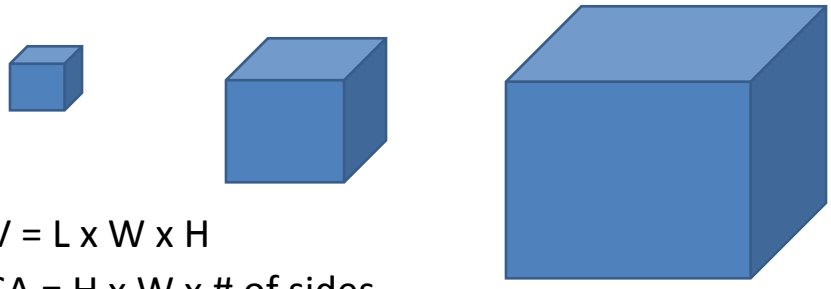
Major Compounds

- Carbohydrates
- Lipids
- Proteins
- Nucleic Acids

Exchanges with Environment

- Cells are the basic unit of exchange, even in large multicellular organisms.
- Why not be just 1 enormous cell???
- Issue of surface area – volume ratios
- As cells increase in size, the volume increases faster than the membrane's surface area.
- More demand for exchange, not enough area to make the exchanges!

SA to Volume Ratios



V = L x W x H

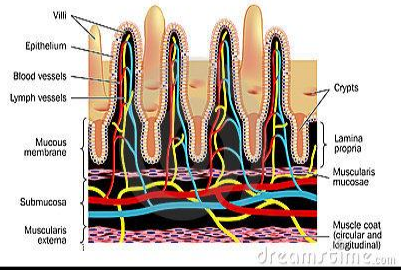
SA = H x W x # of sides

SA / V = Ratio

Smaller cells more favorable!

Adaptations for Increasing SA Without Significantly Increasing V

- Intestines: Specialize in absorption of materials = **microvilli**
- Lungs: Specialize in gas exchange = **alveoli**
- Roots: Specialize in absorption of water = **root hairs**



The Amoeba is a rather large **heterotrophic unicellular** protozoan, capable of shifting it's body form into many shapes due to its lacking a cell wall.

Draw the most suitable body form for an amoeba that is actively exchanging materials with its environment, and justify your drawing with a written explanation. In addition, include ***what types of materials*** it would need to exchange during its metabolism!

Membranes

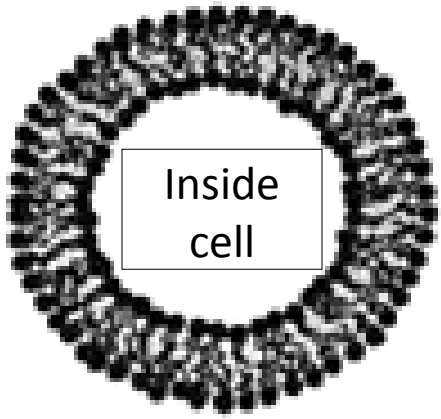
- What defines a cell?
  - Nucleic Acid, usually DNA
  - Cytoplasm
  - Ribosomes
  - **MEMBRANES** to contain it all!

Membrane Evolution

- In order for cells to have evolved, molecules must have aggregated together to form a barrier…how & why would this happen???
  - Think about oil & water!

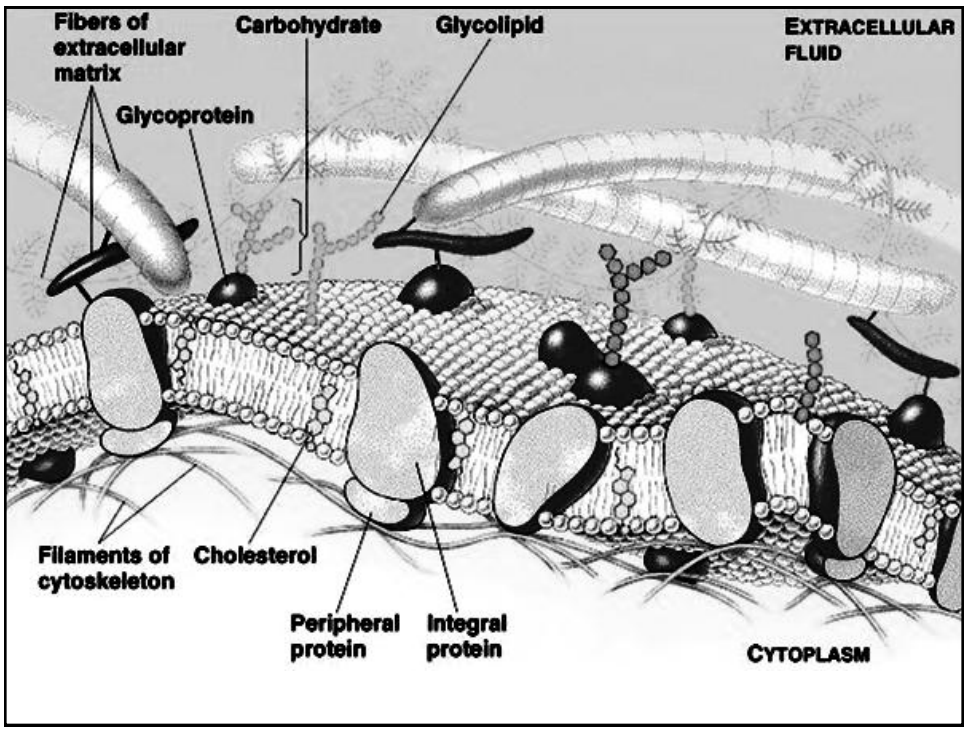
Membrane Structure

- 2 Layers of **Phospholipids**
- "heads" = hydrophillic
  - Phosphates are polar like water
- "tails" = hydrophobic
  - Fatty acids are non-polar (like oil)



Membrane Structure

- More to the story…
- Membranes also have a variety of molecules embedded within or sticking out of them.
- Called the "Fluid-Mosaic Model"
  - Fluid = The Bilayer of Phospholipids
  - Mosaic = The stuff stuck in the membrane

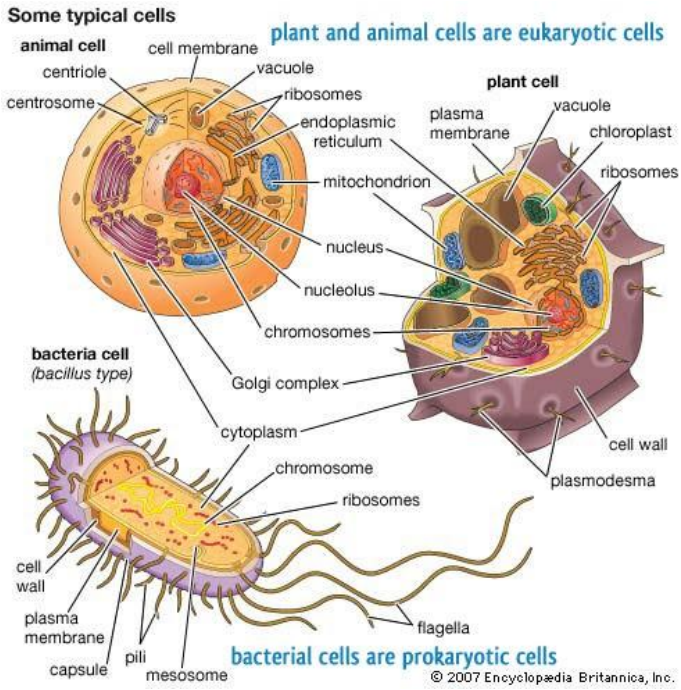


Cell Walls

- Plants have cell walls external to the membrane. Made of a carbohydrate called cellulose.
- Prokaryotes, Fungi & many protozoa have cell walls too.
- All serve as structural boundaries and permeability barriers for some substances.

Eukaryotes vs. Prokaryotes

- ***Internal*** membranes facilitate cell processes by minimizing competing interactions and by increasing surface area where reactions can occur
- Prokaryotes (such as???) LACK these internal membranes, meaning no organelles!
- Organelles compartmentalize internal processes and specific enzymatic reactions.

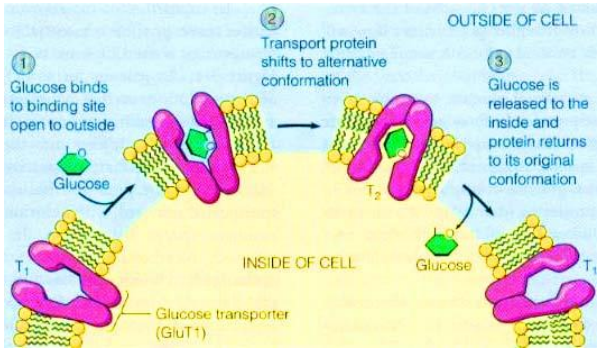


Transport Through Membranes

- What CAN move freely through membranes?
  - Small nonpolar molecules
    - N_2, CO_2, O_2
  - Small, uncharged polar molecules
  - Water: KIND OF…passes through special channels called **aquaporins**.
  - Travel via PASSIVE TRANSPORT, no free energy required. Ex. Diffusion, Facilitated diffusion

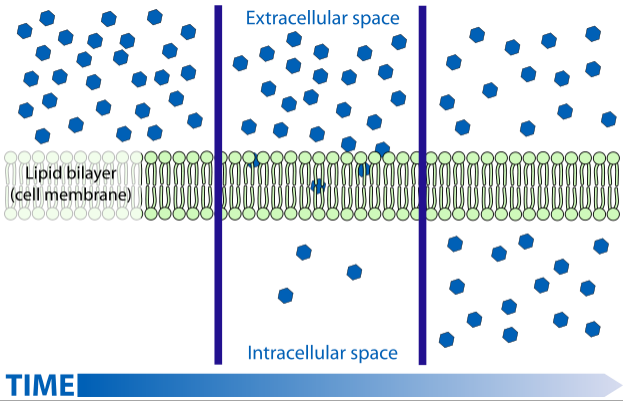
Passive Transport

- Primary role in the import of resources & export of wastes
- Membrane proteins play a role in **facilitated** diffusion of charged & polar molecules



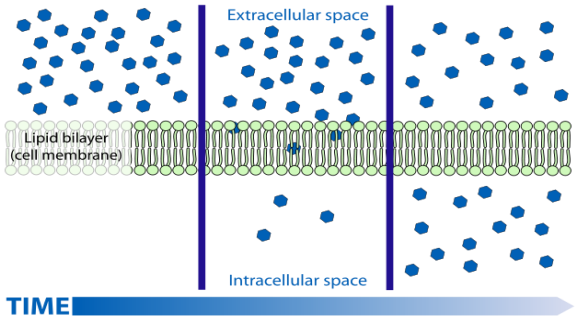
Passive Transport

- Movement of molecules follows a gradient from areas of high concentration to areas of low concentration.



Passive Transport

Hypertonic Isotonic



Hypotonic Isotonic

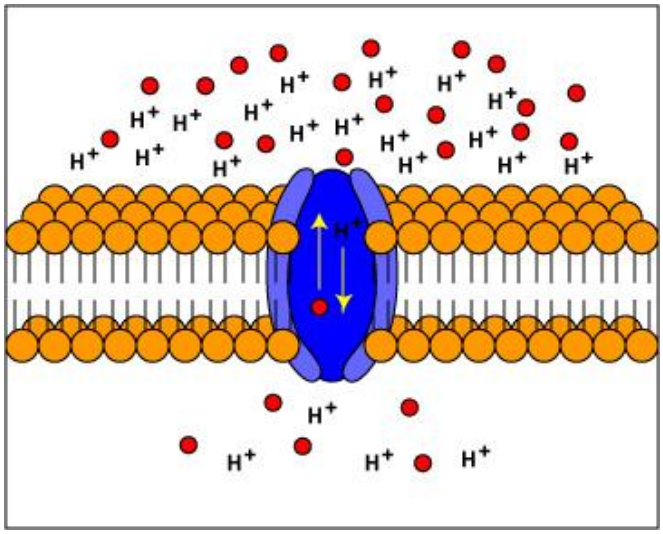
Transport Through Membranes

- What CAN'T move freely through membranes?
  - Large polar molecules (ex. Sugars)
  - Ions (ex. Na^+ Cl^- H^+)
  - Travel via ACTIVE TRANSPORT
    - Proton pumps (photosynthesis, cell respiration!)
    - Protein gated channels

Active Transport

- Requires free energy to move molecules from areas of low concentration to areas of high concentration
- ATP is used by proteins embedded in the membrane to “move” molecules/ions across the membrane to establish and/or maintain concentration gradients

Active Transport

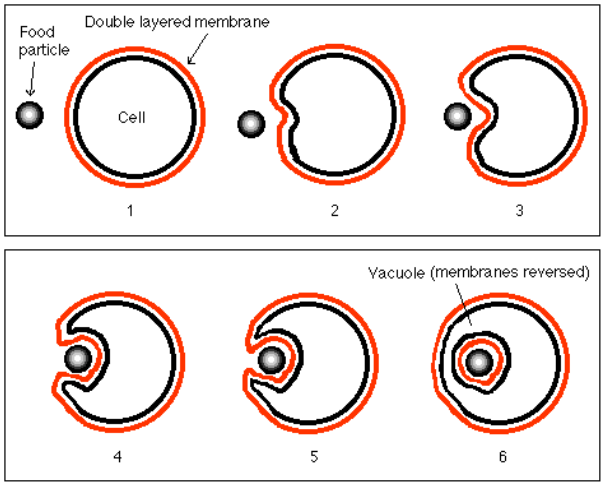


Active Transport

- Movement of large molecules require either exocytosis or endocytosis
- Endocytocis brings materials into cells
- Exocytosis exports materials from cells

Active Transport

- Endocytocis



Active Transport

Exocytosis